Working Paper

The Changing Approach to Water-Quality Management in the United States

Peter Shanahan

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THE CHANGING APPROACH TO WATER-QUALITY MANAGEMENT IN THE UNITED STATES

by Peter Shanahan[1]

INTRODUCTION

The purpose of this paper is to provide a review of water-quality management legislation and policy in the United States with a focus on those elements that may be relevant to the Central and Eastern European (CEE) region. The degraded water quality of some rivers and other water bodies in the CEE countries has been widely reported and is a distinct contrast to conditions that now prevail in much of western Europe and the United States. However, similar degraded conditions were common in the west prior to the institution of strict water-quality legislation in the 1970s and 80s. Thus, the historical development of water-quality management in the west may provide examples useful to CEE countries as they develop new institutions and legislation directed to water-quality management.

The history of water-quality management in the United States is long and complex, and this short review is necessarily limited. The review provides impressions of selected aspects of the U.S. experience rather than a comprehensive or systematic analysis. There are several more complete texts on the history of American water policy. The review published by the Water Pollution Control Federation (now the Water Environment Federation) provides a relatively thorough and evenhanded history of past legislation and a detailed discussion of the 1987 Clean Water Act (WPCF, 1987) including its full text. Retrospective reviews of the effects of the 1972 Federal Water Pollution Control Act Amendments have been prepared by the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA, undated) and the Natural Resources Defense Council (NRDC) (Alter *et al.*, 1993). Both were prepared with the aim of influencing future water-quality legislation and carry the biases of the preparing organizations. Rogers (1993) examines both the water-resources and water-quality aspects of water policy in the U.S.

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BACKGROUND OF U.S. WATER-QUALITY POLICY

Water-quality policy in the U.S. is shaped by the nation's organization and system of governance. The aspect that is probably the most significant to water-quality management is the separation of powers between the federal government and the fifty individual states. The U.S. Constitution reserves to the states authority over all matters not specifically assigned to the federal government. However, the power of the federal government to regulate commerce between the states has been taken to create authority over navigation and thereby over water-resources and water-quality management (Rogers, 1993). The tension between the role of the federal government and that of the states has been a continuing issue over the years as new federal water-quality legislation progressively increased the duties and authority of the federal government and at the same time assigned more tasks to the states. The resulting division of responsibility between the states and central government is thus peculiar to the U.S. and probably has limited relevance to the CEE countries.

A second and more universal characteristic of the American system is division of management authority by political boundaries (state borders) rather than hydrologic boundaries (river basins). This creates occasionally peculiar water-quality requirements. For example, in the 1970s, the author assessed the ability of the Peach Bottom Nuclear Power Station to comply with regulations governing thermal discharges. The power station discharges cooling water into Conowingo Reservoir, an impoundment of the Susquehanna River in Maryland and Pennsylvania. The station is located in Pennsylvania a short distance upstream of the border with Maryland which crosses the reservoir. The analysis showed that discharge of waste heat was often limited by the requirement to meet Maryland's receiving-water-quality standards for temperature at the state boundary rather than the more immediate mixing-zone limits imposed by the state of Pennsylvania. While international boundaries will inevitably create differences between countries, this kind of awkward requirement can be avoided at least within the CEE countries by organizing management on a river basin basis.

Another characteristic of the American system is common in other countries. This is the separate management of water quality and water quantity. In the U.S., the Environmental Protection Agency (EPA) and corresponding state agencies have responsibility for water-quality management, while responsibility for water quantity is scattered over numerous agencies including, on the federal level, the U.S. Army Corps of Engineers, Bureau of Land Management, Bureau of Reclamation, and Geological Survey; on the interstate level, interbasin commissions and special agencies such as the Tennessee Valley Authority; and on the state level, a wide variety of agencies that are organized differently in each state. The dispersion of water-quantity management authority makes coherent management of water quality and water quantity difficult.

A final characteristic of the United States is its unique position as the most litigious society in the world. Actual or potential lawsuits weigh on the design and execution of water-quality legislation and management. Lawsuits have significantly influenced the national direction of water-quality management as, for example, in the case of the NRDC suit that instituted stronger controls on toxic pollutants and eventually became a part of the federal Clean Water Act (see below).

LEGISLATIVE HISTORY OF U.S. WATER-QUALITY MANAGEMENT

Table 1 summarizes the legislative history of water-quality management in the United States. The table emphasizes that U.S. water-quality management has changed continuously over the years as new legislative approaches were tried and abandoned. This, more than anything, is the finding from the U.S. most relevant to the CEE countries: that water-quality legislation and policy should be viewed as a dynamic entity that will change as the economy, political system, and wishes of the citizenry change.

There are two major periods in the U.S. legislative history, before and after the Federal Water Pollution Control Act Amendments of 1972. The period before 1972 was one of increasingly comprehensive regulation and growing federal authority in water quality, culminating in the sweeping transformation caused by the 1972 Amendments. Since 1972, the basic framework of the Federal Water Pollution Control Act Amendments have been maintained, but with regular adjustments and changes.

Pre-1972: The Water Quality-based Approach

Water-quality management of the pre-1972 period was directed to receiving-water quality. At first, receiving-water requirements were expressed in qualitative terms, but beginning with the Water Quality Act of 1965, states were required to develop water-quality standards for specific water bodies. Wastewater discharges were limited to levels that ensured that water-quality standards were met in the receiving water. This water quality-based approach proved difficult and ineffective. First of all, the determination of effluent water-quality limitations required a specific analysis for each receiving water body that accounted for each discharge. For example, the amount of effluent that could be assimilated by a river needed to be calculated and then allocated among the various dischargers. Neither the analytical tools nor the technical personnel were up to this task and particularly not to completing it in a short time for all of the nation's streams. That the wasteload allocation process depended upon complex mathematical models developed with assumptions and judgments by technical analysts further weakened the process and made it vulnerable to legal challenge. The result has been described as a "regulatory nightmare" (WPCF, 1987) of massive technical effort but only feeble enforcement and small accomplishment.

Table 1

Timeline of U.S. Water-Quality Management

Year	Legislation or Action	Summary
1899	River and Harbor Acts	Provided limited controls on disposal of refuse
1948	Water Pollution Control Act	Provided limited federal authority for interstate waters, some federal funding for municipal wastewater treatment, and water quality-based controls on wastewater discharges
1956	Federal Water Pollution Control Act	Increased federal funding for municipal wastewater treatment
1961	Federal Water Pollution Control Act Amendments	Increased federal funding for municipal wastewater treatment
1965	Water Quality Act	Increased federal funding for municipal wastewater treatment; required states to develop water-quality standards; established Federal Water Pollution Control Administration; provided limited federal enforcement authority
1966	Clean Water Restoration Act	Increased federal funding for municipal wastewater treatment
1970	President Nixon directs U.S. Army Corps of Engineers to issue discharge permits under 1899 acts	Established short-term discharge permit system
1972	Federal Water Pollution Control Act Amendments (Clean Water Act)	Dramatically increased federal funding for municipal wastewater treatment; established discharge permit system, controls on industrial discharges, and water-quality planning procedures; emphasized technology-based limits for discharge permits
1976	EPA-NRDC Consent Decree	EPA settled lawsuit with NRDC, agreeing to designate 129 "priority pollutants" (toxic pollutants) and establish corresponding effluent limitations
1977	Clean Water Act	Corrected problematic parts of 1972 law; incorporated NRDC consent decree into controls on toxic, conventional, and nonconventional pollutants
1981	Construction Grant Amendments	Reduced federal funding for municipal wastewater treatment; required states to revise water-quality standards to incorporate toxic pollutants
1984	Policy on Water Quality-based Toxics Control	Strengthened EPA policy on managing toxic pollutants
1987	Water Quality Act	Added permit requirements for stormwater; required nonpoint source evaluations by states; phased out federal funding of municipal wastewater treatment, replacing grants with a loan fund
1990	Food, Agriculture, Conservation, and Trade Act	Provided water-quality assistance and incentives, and land conservation programs for agriculture
1991	NPS Initiative	Increased emphasis on nonpoint-source pollution control

1972: The Federal Water Pollution Control Act Amendments

In the early 1970's the U.S. Congress faced a public increasingly concerned about water quality. The first Earth Day in April 1970 raised the nation's consciousness of environmental problems generally; reports of gross water pollution, such as when the Cuyahoga River in Cleveland, Ohio caught fire and burned in June 1969, raised awareness of water pollution particularly. Reports in the popular press reinforced the growing conclusion that the current water-pollution control laws were inadequate.

After lengthy debate and revision, the 92nd U.S. Congress passed Public Law 92-500, which is formally named the Federal Water Pollution Control Act Amendments of 1972 but is generally referred to as the Clean Water Act. President Richard Nixon vetoed the act, believing its $18 billion appropriation for municipal treatment works was too high, but Congress overrode the veto and PL92-500 became law in October 1972. Although strictly only amendments of the existing federal law, PL92-500 had in fact entirely rewritten the nation's approach to water-quality management. The objective of the law was "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Water-quality standards for receiving water remained a part of the approach, but were subordinated to a new system of effluent-based discharge permits and controls. The goal for this system was ambitious: to achieve fishable-swimmable waters nationally by 1977 and eliminate the discharge of pollutants to the nation's waters by 1985. The discharge permit system was thus named the National Pollutant Discharge Elimination System (NPDES).

The approach to water-quality control under the Clean Water Act was twofold. At minimum, municipal and industrial wastewater discharges were required to provide wastewater treatment commensurate with available treatment technology. This level of treatment was required whether or not it was needed to meet receiving water-quality standards. In other words, in many streams the level of treatment required would produce water quality that was better than required by standards. However, if the technology-based limitations were not sufficient for receiving water-quality standards to be achieved, then additional treatment was required. This condition essentially required continued reliance on wasteload allocation and a water quality-based approach, but for many fewer water bodies than under the previous laws. Technology- and water quality-based limits formed the basis for pollutant limits in wastewater discharge permits. Permit conditions were enforced by stiff fines for permit violations.

The technology-based requirements of the Clean Water Act stipulated increasing levels of treatment over time. By July 1977, industrial dischargers were required to treat wastewater with the "best practicable control technology currently available"

(BPT). By July 1983, the "best available technology economically achievable" (BAT) was required. Municipal dischargers were required to achieve similar goals on a similar schedule. Publicly-owned treatment works (POTWs) were required to provide secondary wastewater treatment achieving a minimum of 85% removal or 30 milligrams per liter (mg/l) average monthly concentration for both biochemical oxygen demand (BOD) and total suspended solids (TSS). Municipalities (but not private industry) were aided in meeting these goals with generous subsidies. Under the Construction Grants Program, the federal government provided 75% of the cost of new treatment works. States often contributed an additional share, so the cost to the local municipality might only be one tenth of the total cost of new construction.

Finally, the Clean Water Act established several planning programs to facilitate the rational expenditure of funds while achieving improved water quality. Four main program procedures were defined. Section 201 of the Act required "facilities planning" for individual treatment works. Section 208 defined areawide plans to account for the combined effects of nonpoint sources (NPS) of pollution and municipal and industrial point-source discharges. In practice, 208 plans tended to focus on NPS pollution. Section 209 of the act established a planning procedure for interstate river basins, and Section 303 for intrastate basins. The resulting water-quality management plans provided a blueprint by which the states would meet water-quality standards and were the vehicle by which water quality-based analyses were completed. Usually, water-quality management plans used water-quality models to develop wasteload allocations and otherwise plan wastewater treatment improvements throughout a river basin. An adjunct to the planning process was the requirement under Section 305 that the states monitor water quality, filing a report every other year on measured conditions.

Post-1972: The Effluent Limitations Approach

The effluent limitations approach provided substantial administrative advantages over the previous system. Nonetheless, aspects of the 1972 Act required continuing adjustments and changes over time.

Section 307 of the Clean Water Act required the EPA to develop information to support the implementation of water-quality standards for toxic pollutants. However, the agency's progress was hampered by a lack of technical information. In 1975, the NRDC and other environmental organizations dissatisfied with the EPA's progress on toxic pollutants sued to force a more rapid pace. This lawsuit was settled in 1976 with an agreement on a timetable to establish effluent limits for a list of 129 toxic "priority pollutants." The agreement was formalized in a court-backed consent decree.

EPA progress toward the ambitious goals of the Clean Water Act was slow in other respects. Determination of technology-based effluent limitations for the vast number and variety of industrial discharges and subsequent issuance of permits in the little more than two years provided by the act was an impossibility. At the same time, the many planning procedures and other requirements promulgated for the Construction Grants Program had more than doubled the time needed to construct new municipal treatment plants. Analysis of the funds required to achieve the goals of the Clean Water Act showed unrealistically high expenditures would be required to achieve these goals. Above all, it become clearer and clearer that the technology implementation deadlines set for 1977 and 1983 were infeasible.

The problems of the 1972 law were addressed by the Clean Water Act of 1977. This law maintained the overall framework of the 1972 Clean Water Act, but made many corrections, including relaxing some deadlines and incorporating the new toxic pollutant controls established under the NRDC consent decree. Requirements for industrial discharges were modified and somewhat eased. More significantly, other changes narrowed the types of works that could be funded by the Construction Grants Program, and eased the requirements for rural and small POTWs. Similar changes aimed at reducing costs to the federal government were made in 1981 when the Construction Grants Program was again revised.

Implementation of controls on toxic pollutants was further defined by the EPA in a 1984 policy statement (Federal Register, 1984) and technical guidance (U.S. EPA, 1985c, 1991a). These documents introduced a new concept for toxic pollutant control: whole effluent toxicity (WET). WET is evaluated through bioassays that measure the toxicity of complex wastewaters to daphnia and fathead minnows. Concentration limits for wastewaters were still set for individual toxic compounds, but toxicity of the whole effluent now needed to be determined and, if need be, treated. Correcting whole effluent toxicity is usually complicated inasmuch as the source of the toxicity needs to be found and the appropriate treatment technology identified, a process called a Toxicity Reduction Evaluation.

The last significant revision of federal water-quality policy was the Water Quality Act of 1987. This law also preserved the basic structure of the 1972 act but continued to fine-tune its provisions. The biggest change was to phase out the Construction Grants Program over a five-year period, replacing the outright grants with low-interest loans through the State Revolving Funds Program. The law also provided increasing emphasis on nonpoint source pollution, adding stormwater discharges to the NPDES system and requiring the states to complete NPS assessments. The emphasis on nonpoint sources was reinforced in the EPA's NPS Agenda, issued in 1989 (U.S. EPA, 1989b).

Summary

This review of the 100-year legislative history of water-quality management in the United States reveals a process of continuous evolution. It has now been over 20 years since the United States ushered in its modern era of water-quality management with passage of PL92-500, the Federal Water Pollution Control Act Amendments or Clean Water Act. During that time, the basic framework of water-quality management has been preserved but numerous changes have been made. Three major revisions of the Act occurred in 1977, 1981, and 1987 and are described above; smaller changes were required in most other years since 1972 (WPCF, 1987).

The framework of the United States laws may be entirely or partially inappropriate for Central and Eastern Europe, and I do not recommend it as a specific model. Nevertheless, like the U.S. before them, these countries should anticipate a future process of revision and adjustment as they pass and implement new legislation for water-quality management.

ECONOMIC HISTORY OF U.S. WATER-QUALITY MANAGEMENT

The history of public and private expenditures required in the United States for water-pollution control is well documented and provides useful perspective for the countries of Central and Eastern Europe. The expenditures were vast and completely underestimated. The 1972 Act was passed by Congress over President Nixon's veto because he found the $18 billion allotment for publicly owned treatment works excessive. An irony is that after 15 years and $52 billion dollars, the Congress again overrode a President's veto—this time by President Reagan—because he found a "final" $18 billion dollar extension of the Construction Grants Program again excessive (WPCF, 1987).

Figure 1 shows the annual funds appropriated and actually expended under the Construction Grants and State Revolving Fund Programs in current dollars (not adjusted for inflation). The figure illustrates the great increase in funding following passage of the Clean Water Act, although the actual expenditures lagged the appropriation by several years.

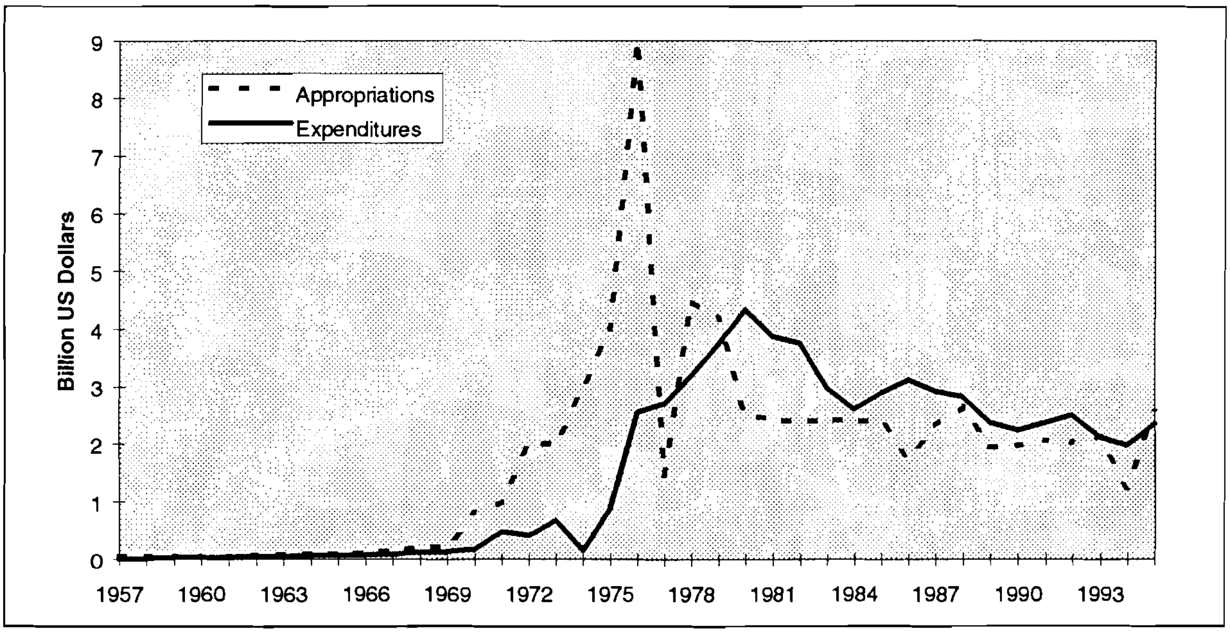

Figure 1

Construction Grants Program Appropriations and Expenditures in Current U.S. Dollars (U.S. EPA, 1974; Braddock, 1996)

Although construction grants increased dramatically and rapidly after 1972, actual total expenditures increased more slowly and steadily. Figure 2 shows national annual expenditures in inflation-adjusted dollars for the period 1972 through 1993 from

U.S. Bureau of Economic Analysis (Rutledge and Leonard, 1992, 1993; Rutledge and Vogan, 1995). Pollution abatement expenditures were not counted prior to 1972. The aforementioned administrative delays caused by the planning and Construction Grants processes are clearly evident in the delay in the increase in capital expenditures between 1972 and 1975 (long-dashed line in Figure 2). The period of greatest investment lasted about six years, although capital expenditure continues at a lesser, but nevertheless substantial, rate throughout the period of the data.

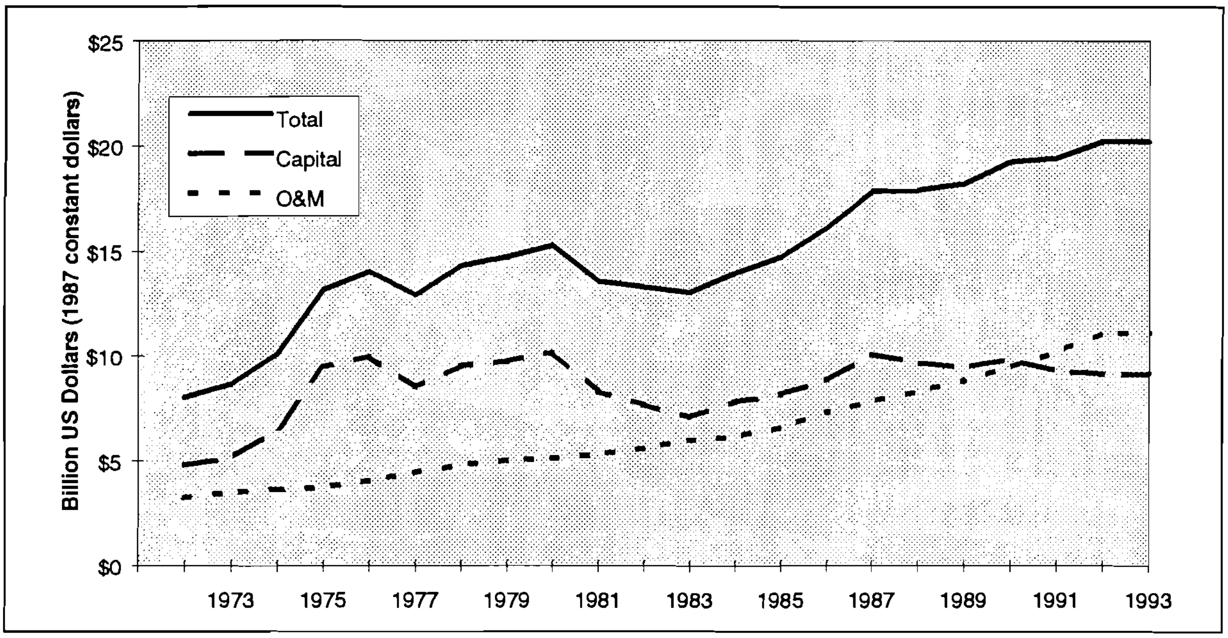

Figure 2

Expenditures for Municipal Wastewater Treatment in 1987 Constant U.S. Dollars (Rutledge and Leonard, 1992, 1993; Rutledge and Vogan, 1995)

While capital investment declined and more-or-less leveled off after a period of intensive investment, the cost of operation and maintenance (short-dashed line in Figure 2) has increased throughout the period, pausing only in 1993 when it remained level with the previous year. Significantly, operation and maintenance expense (O&M) crossed over capital expenditure in 1990 and has exceeded it every year since. The eventual burden of operations and maintenance was overlooked by the Clean Water Act, which provided generous capital investment subsidies but no cash assistance for O&M. This burden now falls entirely on the municipalities and ultimately on taxpayers or ratepayers.

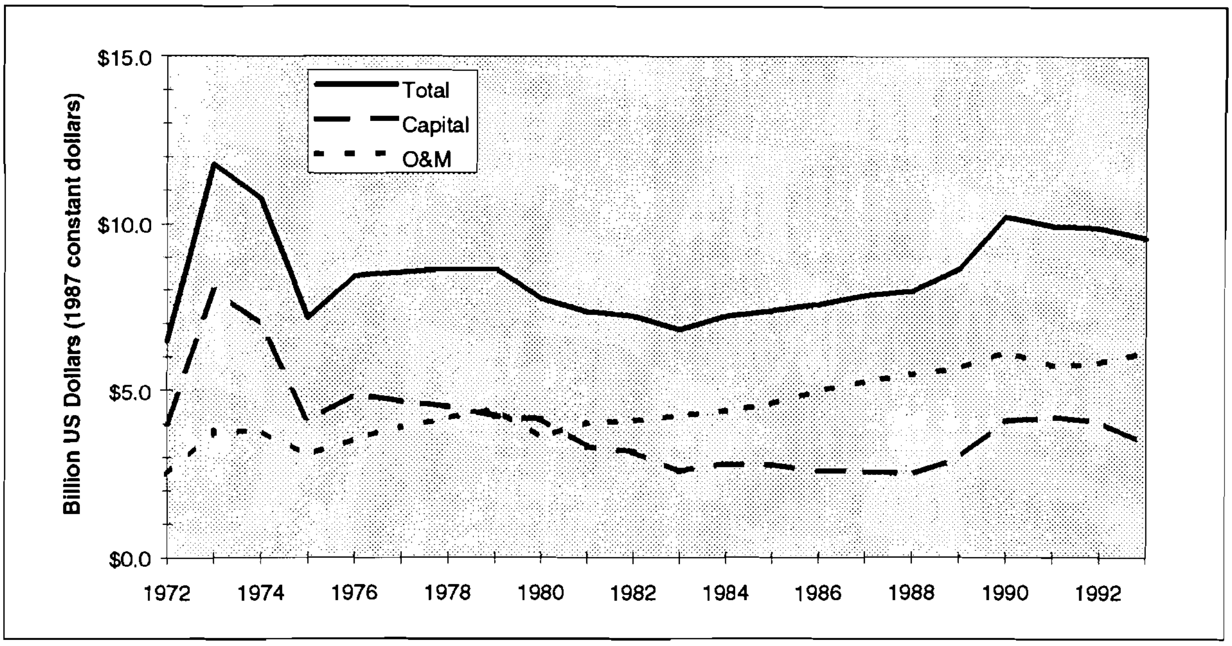

Figure 3

Expenditures for Industrial Wastewater Treatment in 1987 Constant U.S. Dollars (Rutledge and Leonard, 1992, 1993; Rutledge and Vogan, 1995)

Figure 3 shows corresponding expenditures for industrial pollution control. Private industrial concerns did not receive the mixed blessings of government grants and their delaying procedures and paperwork, and reacted to the Clean Water Act with far more immediate capital spending. Capital expenditure tapered off after only two years and remained relatively steady thereafter. Interestingly, and unlike municipal expenditures, O&M costs fluctuate somewhat in proportion to capital expenditure. This may be the result of initially higher O&M costs when the sometimes-esoteric industrial treatment systems were first operated. After experience with the system, O&M costs dropped from their initially higher level. Nonetheless, industrial O&M costs increase progressively during the 22-year period, crossing over capital costs around 1979, many years before the similar crossover seen in the municipal expenditures.

The greatest annual capital expenditures for pollution abatement came between 1974 and 1981, a period of substantial growth in the U.S. economy during which the U.S. gross domestic product (GDP) increased 18% (Figure 4). Expenditures for water-pollution control (including both municipal and industrial treatment) represented less than 1% of GDP during this period. The percentage of GDP expended on water-pollution control increased from 0.5% of GDP in 1972 to 0.8% in 1973 and declined thereafter. Since 1983 water-pollution control expenditure has held relatively steady between 0.5 and 0.6% of GDP.

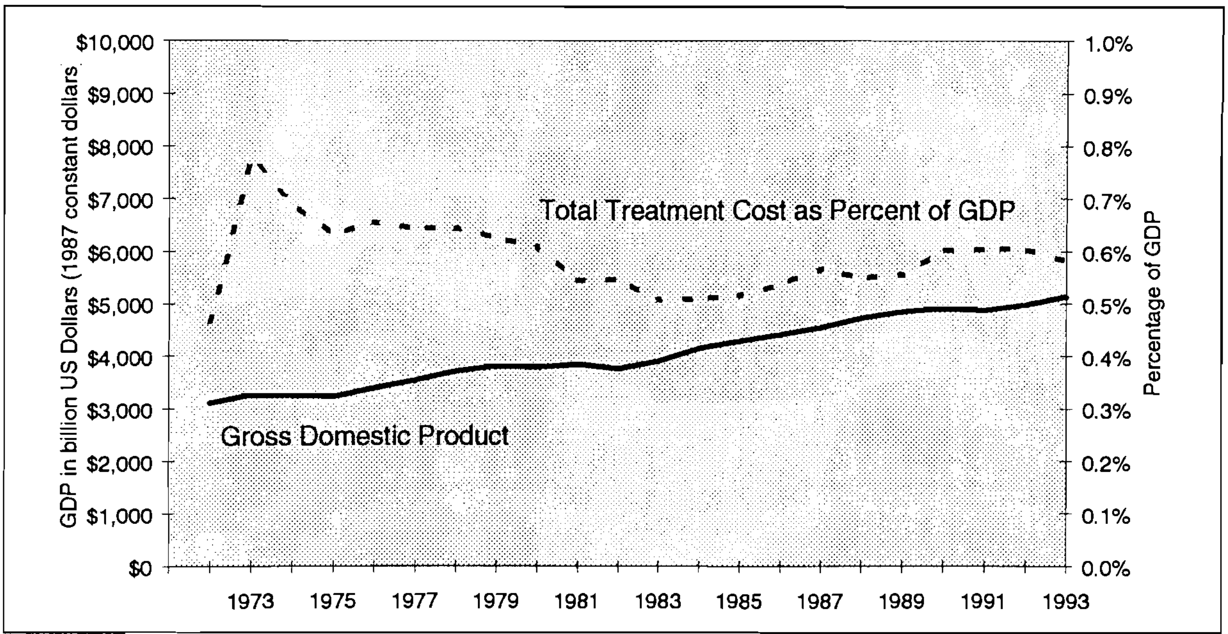

Figure 4

U.S. Gross Domestic Product in 1987 Constant U.S. Dollars
(Bureau of Economic Analysis, 1994)

All told, over $500 billion (1987 dollars) has been spent on water-pollution abatement and control since passage of the 1972 Amendments. This is in line with the costs anticipated by legislators when the Clean Water Act was passed. Just prior to passage of the Act, EPA officials reported a cost estimate of $316 billion dollars in 1971 dollars to achieve the zero-discharge goal of the then-proposed legislation (Luken and Pisano, 1972). Their estimate equates to approximately $822 billion in 1987 dollars based on adjustment with the Producer Price Index (PPI from Statistical Abstract, 1995). Thus, expenditures to date are less than the original cost estimate, although the zero-discharge goal has not been met yet either. That goal was, of course, anticipated by the Clean Water Act to be met by 1985.

Although actual expenditures appear to be commensurate with the original estimates, cost forecasting for municipal treatment bedeviled the EPA during the early years of the Clean Water Act. Figure 5 illustrates the early history of the annual "Needs Survey," the EPA's forecast of future expenditures under the Construction Grants Program. Noteworthy are the very high costs estimated in 1974 and 1975, the first estimates under the new law. These high cost estimates startled legislators and threatened to derail the clean water effort (WPCF, 1987). Tighter estimating procedures and quality control reduced estimates in later rounds, although the cost of the Construction Grants Program has been a continuing political issue. The major drop in the forecast from 1975 to 1976 came largely as the result of reduced estimates for control of combined sewer overflows which were excessive in early rounds. Costs continue to decline steadily from 1976 as the result of continuing investment in municipal wastewater treatment.

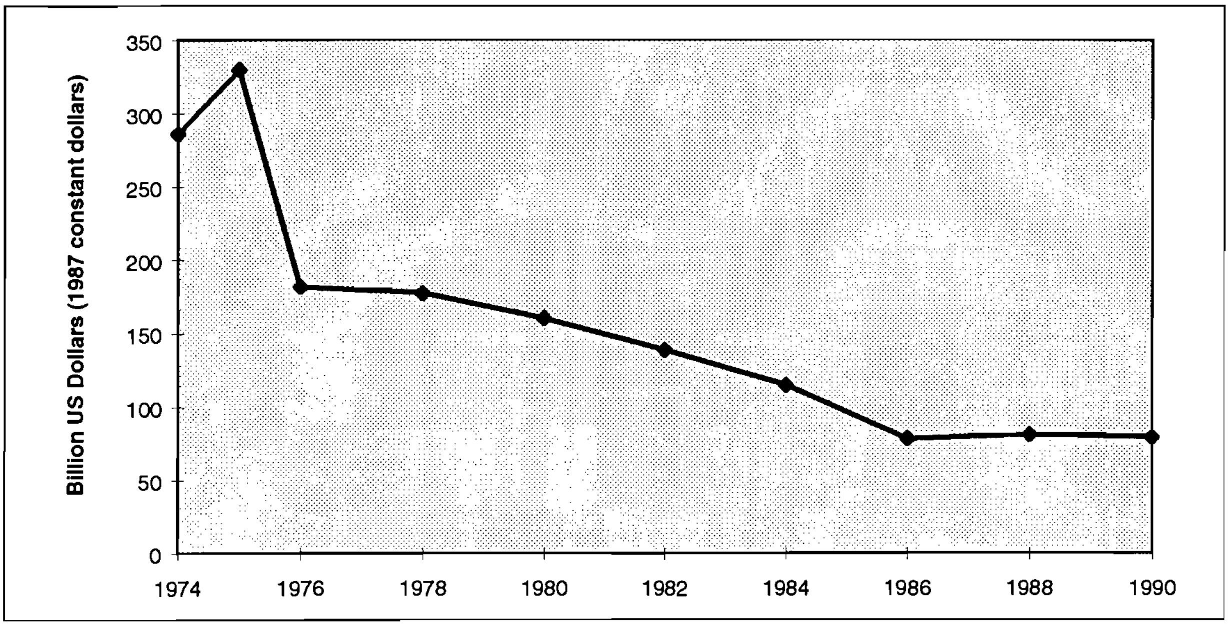

Figure 5

Projected Costs from EPA Needs Survey in 1987 Constant U.S. Dollars
(1977, 1979, 1981, 1985a, 1987a, 1989a, 1991b)

WATER-QUALITY HISTORY OF U.S. WATER-QUALITY MANAGEMENT

Various authors report the immediate effects of the 1972 Amendments in terms of the reduction in effluent discharges. Smith *et al.* (1987b) report that from 1972 to 1981, the BOD load to U.S. rivers from municipal point sources dropped by 46% and from industrial point sources by 71%. The overall drop in BOD from 1974 to 1981 was 60% (Smith *et al.*, 1987a). ASIWPCA (undated) reports that the quantity of BOD generated in the nation increased due to population and economic growth from 15,500 tonnes per day in 1972 to 19,500 in 1992. Nonetheless, the amount discharged decreased from 5,900 to 2,300 tonnes per day. In other words, the BOD removal rate due to treatment increased from 62% to 88%. Although these figures from various authors are not fully compatible, they all indicate a substantial decrease in the quantity of pollutants from point sources.

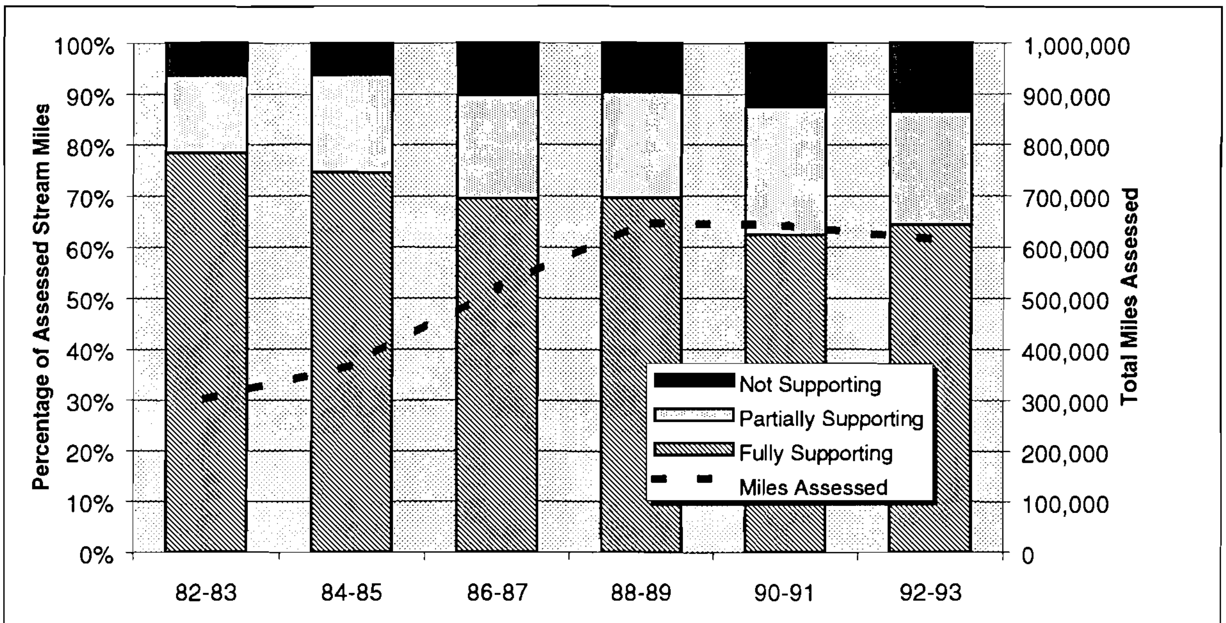

Figure 6

Trends in U.S. Stream Water Quality in Supporting Designated Uses (U.S. EPA, 1985b, 1987b, 1990, 1992a, 1994a, 1995c)

Unfortunately, it is difficult to evaluate the effects of these wasteload reductions in terms of receiving water quality, a problem identified by the U.S. General Accounting Office in 1986 (GAO, 1986). Although Section 305(b) of the Clean Water Act requires the states to file a biannual report on water quality, the early reports were relatively incomplete compared to more recent assessments. Moreover, there is no comprehensive nationwide assessment that predates 1972. A result is evaluations that may mislead. For example, Figure 6 has similar information as an illustration presented by Alter *et* *al.* (1993) in their evaluation of the effectiveness of the water pollution control effort since 1972. This plot, which is based on summary data presented in the EPA's biannual Section 305(b) reports, would seem to show negative progress in improving the nation's water quality. However, the apparent degradation in water quality is as much the result of changing reporting standards as of changing water quality. The national coordinator of the EPA Section 305(b), Barry Burgan, cautions that "comparing one report to the next is not really a valid approach" (Burgan, 1996). He indicates that differences between the biannual reports include the fact that a different subset of water bodies is assessed each year and that standards have become higher over the years, particularly for toxic compounds. For example, the 1992 Water Quality Inventory report states that the percentage of water bodies reported as not supporting aquatic life uses was increased over previous years due to more stringent interpretation of violations due to toxic compounds (U.S. EPA, 1994a). More important than these technical problems, Figure 6 does not provide the comparison with pre-1972 data that is needed for a true evaluation of the 1972 initiatives.

Long-term water-quality monitoring by the U.S. Geological Survey provides another evaluation of the changes in water quality (Smith *et al.*, 1987a,b). Figures 7, 8, and 9 are reproduced from Smith *et al.* (1987a) and show trends in selected water-quality parameters. Figure 7 shows trends in fecal streptococcus bacteria, an indicator of both point (domestic sewage) and nonpoint (agricultural animal wastes) sources of pollution. The data show a clear general trend of decreasing concentration nationwide, a trend also reported for fecal coliform bacteria. Most other pollutants reported by Smith *et al.* show less certain trends however. Dissolved oxygen showed little change and a mixed trend; BOD was not evaluated. Constituents associated with nonpoint sources tended to increase: for example total suspended solids (Figure 8), nitrate, and to a lesser extent phosphorus. Trends in trace elements were variable; Smith *et al.* (1987b) found that concentrations of many trace elements varied due to changes in atmospheric deposition rates. For example, dissolved lead decreased consistently (Figure 9) but this was due to the reduction in the use of leaded gasoline rather than to water-quality controls.

The studies by Smith *et al.* show some improvements in the nation's water quality attributable to the new controls on point sources but just as often a deterioration due to atmospheric and agricultural nonpoint sources. Indeed, they find that atmospheric sources played a surprisingly strong role in determining the nation's water quality, having considerable influence on nitrate, arsenic, and cadmium. Overall, the dramatic water-quality improvements that were the objective of the Clean Water Act were not observed.

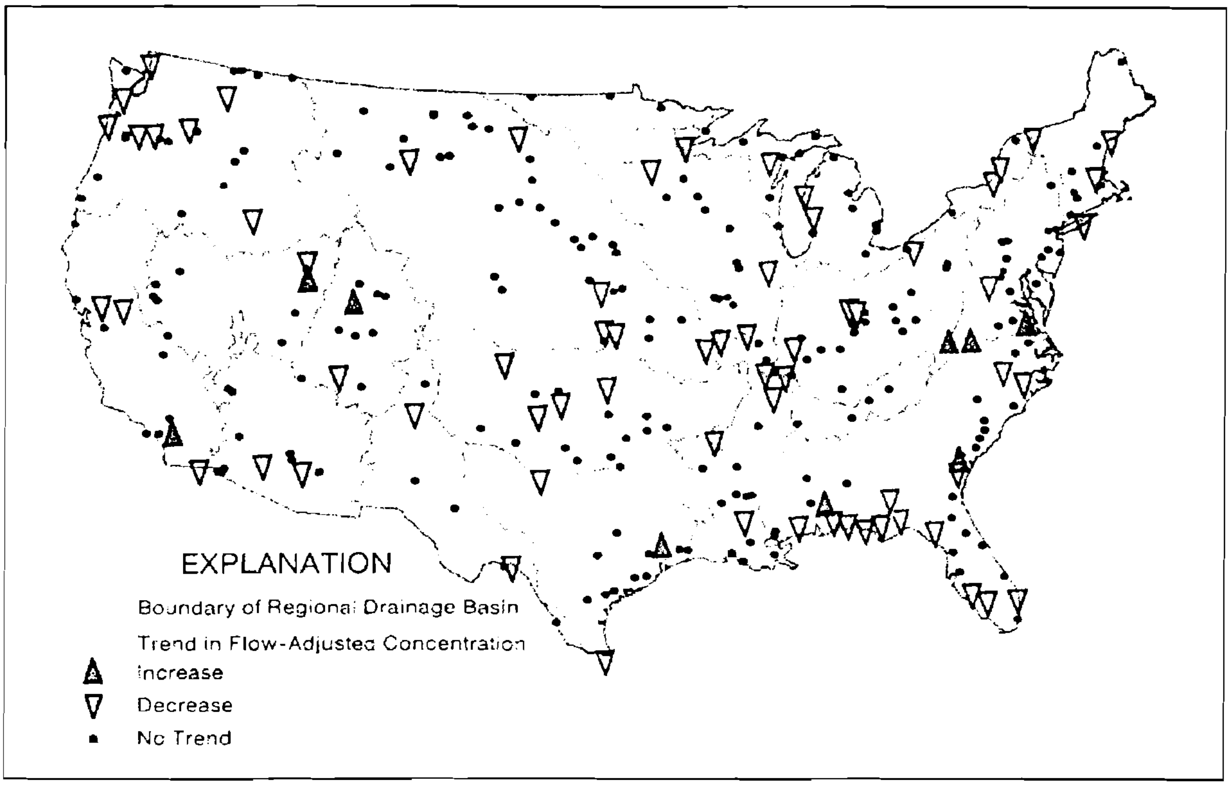

Figure 7

Trends in Measured Concentrations of Fecal Streptococcus Bacteria
(Smith *et al.*, 1987a)

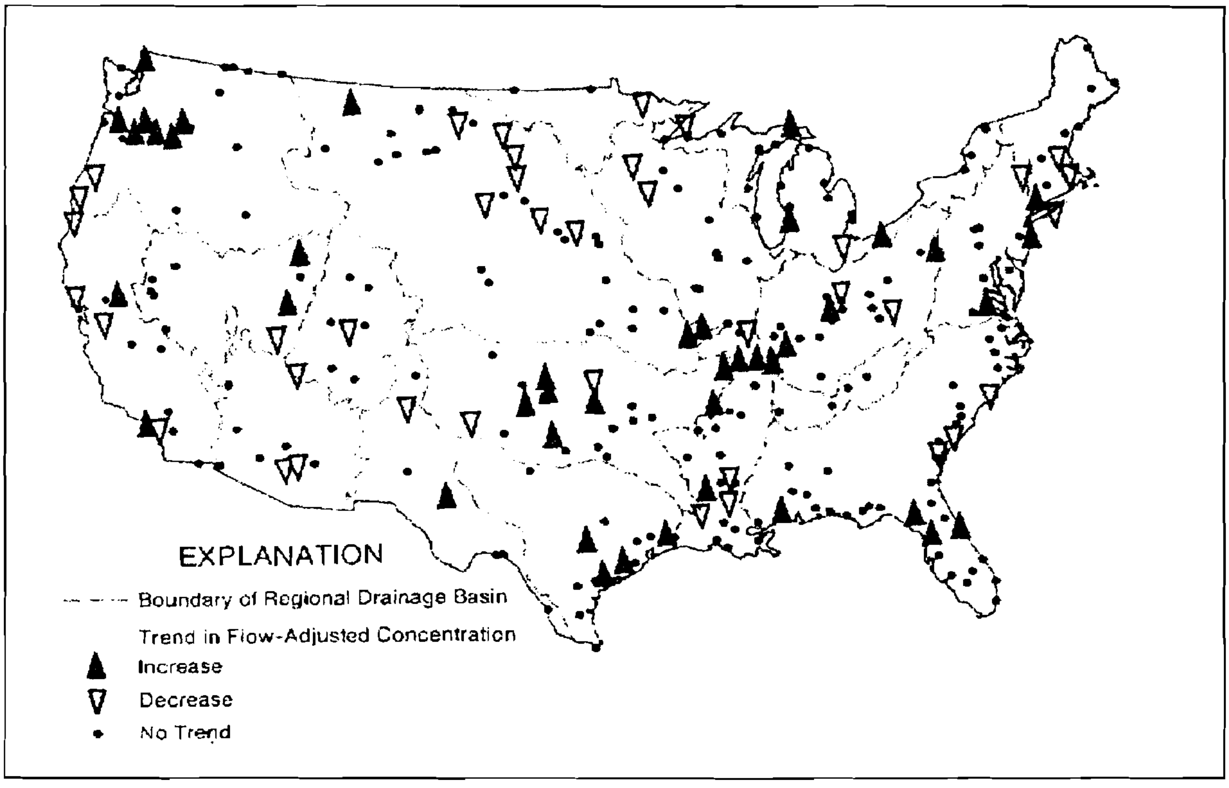

Figure 8

Trends in Measured Concentrations of Total Suspended Sediment
(Smith *et al.*, 1987a)

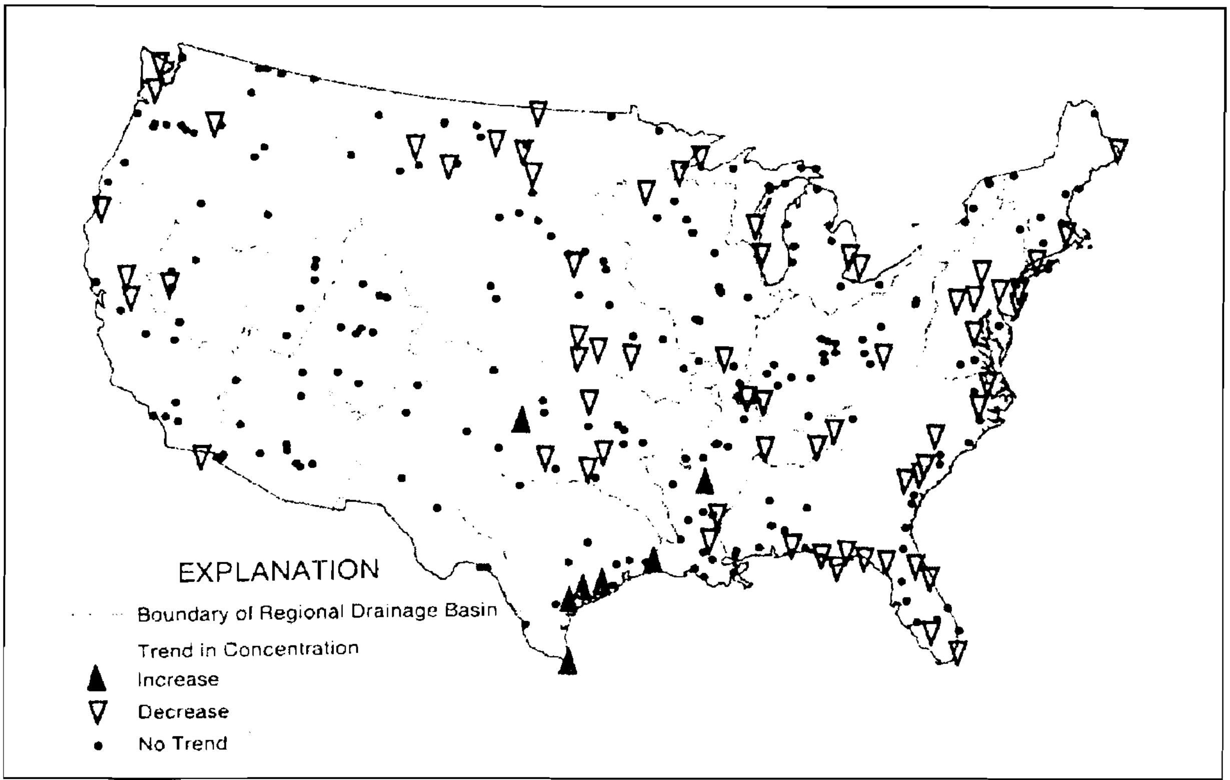

Figure 9

Trends in Measured Concentrations of Dissolved Lead
(Smith *et al.*, 1987a)

The available assessments of water-quality improvements after 1972 are puzzling for their failure to confirm widespread public perceptions of improved water quality. Perhaps they give insufficient weight to the elimination of the grossly degraded conditions that prevailed in some rivers in the 1960s and earlier. For example, Figure 10 shows the improvement in dissolved oxygen and biochemical oxygen demand in the Blackstone River in Massachusetts. The Blackstone had long been highly polluted by both municipal and industrial wastewater (Shanahan, 1994). Prior to 1972, dissolved oxygen dropped to zero or near-zero along 40 kilometers of the river; BOD in the river reached as high as nearly 150 mg/l; the river was little more than a conveyance for wastewater. Like the Blackstone, other highly degraded U.S. rivers were substantially and uniformly improved following 1972 (Patrick, 1992).

Considering situations such as the Blackstone River, our overall conclusion regarding the effectiveness of the Clean Water Act is not that water quality was not improved, as might be concluded from the analysis of the EPA Section 305(b) surveys or the U.S. Geological Survey data discussed above, but rather that the available data fail to show the improvements that actually occurred. A singular deficiency is the absence of comprehensive, consistent baseline data from the period before 1972. Good water-quality databases are in place in many of the CEE countries. Review and, as needed, augmentation of these data should be considered prior to the initiation of large treatment expenditures in order to enable future demonstrations that those expenditures have been effective.

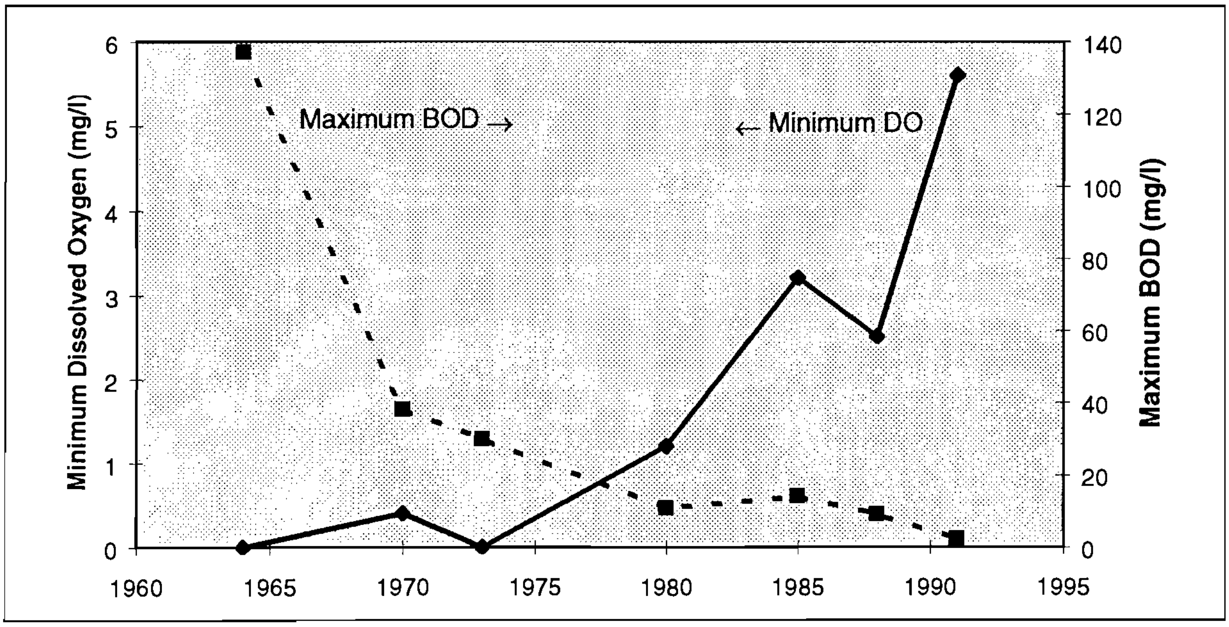

Figure 10

Water Quality of the Blackstone River, Massachusetts , 1964-1991

RECENT U.S. WATER-QUALITY INITIATIVES

The evolution of U.S. water-quality policy did not end with the Water Quality Act of 1987 but in fact continues today. The 1992 Section 305(b) report on the nation's water quality (U.S. EPA, 1994a) shows that of the streams failing to meet water-quality standards, only 22% were prevented from meeting standards by municipal or industrial point source pollutants—nonpoint sources of one type or another were responsible for the remaining failures (Figure 11). Recognition of the importance of nonpoint sources has led to EPA efforts to strengthen management and control of these sources. The EPA's newest program in this direction is called the watershed protection approach.

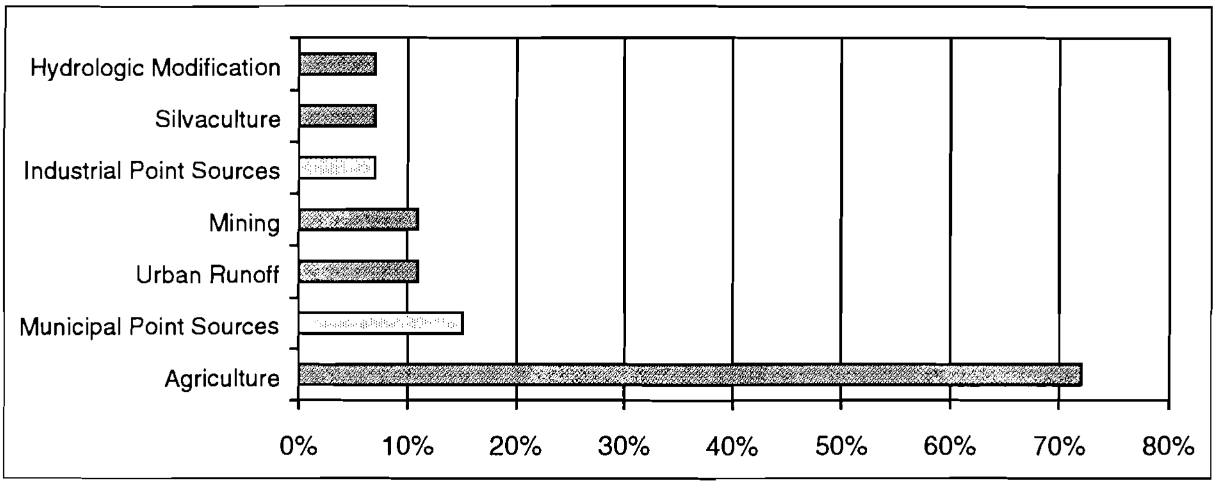

Figure 11

Causes of River Water Quality Impairment in 1990-91
(U.S. EPA, 1994a)

Watershed protection is described by EPA as an "integrated, holistic approach." Conceptually it is straightforward: it seeks to manage water quality at the level of the watershed, considering point and nonpoint sources; water quality, ecology, and hydrology; ground and surface water; and all other factors within the hydrologic basin with potential to influence water quality. The approach is described in general terms in several policy and guidance documents (U.S. EPA, 1991c, 1995a,b, 1996). Figure 12 demonstrates important elements of the approach as presented by EPA. A critical element is the involvement of interested parties (stakeholders) including public and private dischargers, farmers, all concerned government agencies, and so forth. The process otherwise entails, for each watershed, identifying priority problems, addressing those with an integrated site-specific solution, and evaluating success with specific quantitative measurements agreed to early on by the stakeholders. A significant component of the approach is the regulatory flexibility inherent in considering the entire watershed. For example, it is possible to trade between point-source and nonpoint-source controls in order to achieve water quality. This flexibility makes substantial cost savings possible, but also requires a technical understanding of the entire watershed system and receiving water. In essence, this requires renewed emphasis on the water quality-based approach.

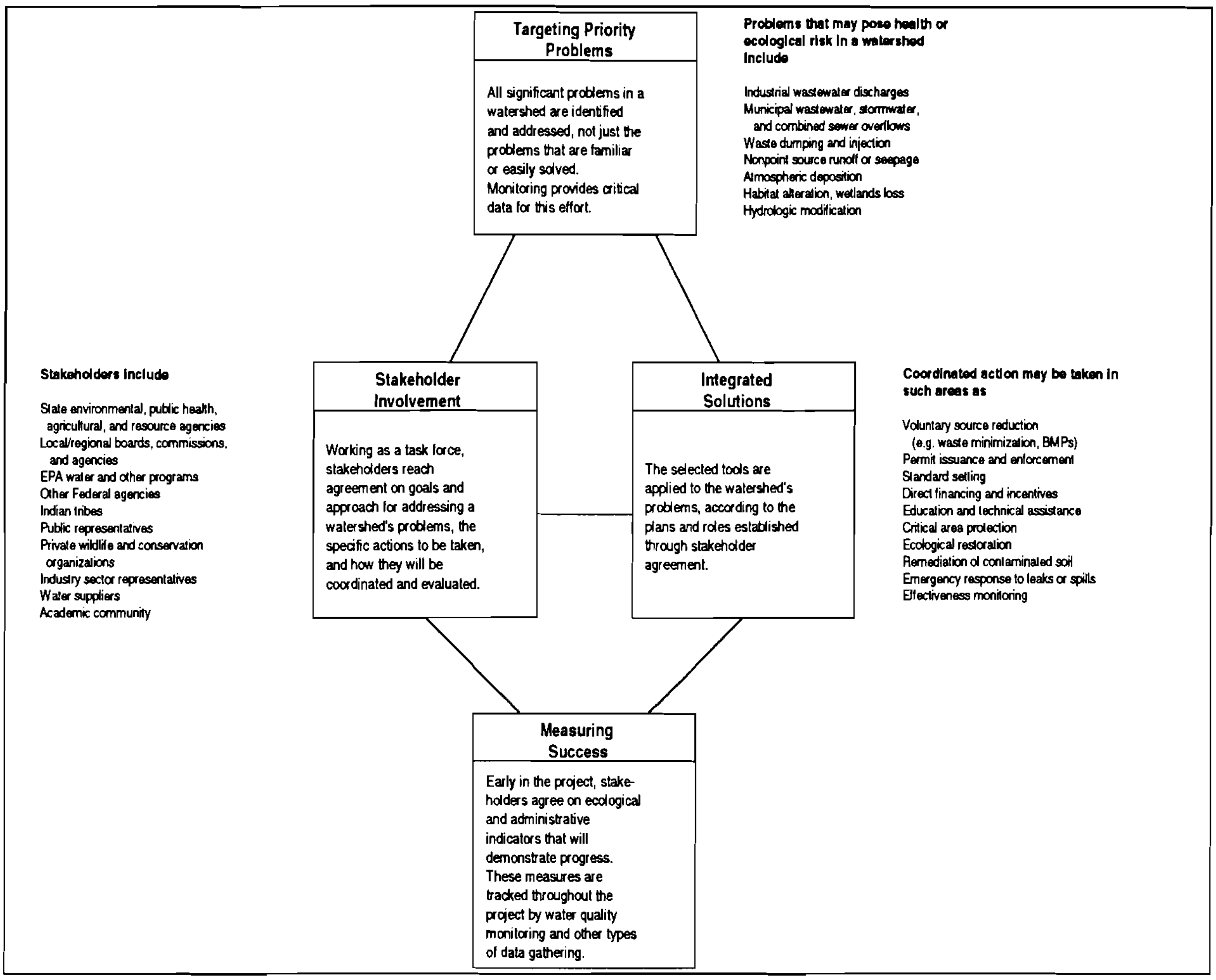

Figure 12

Watershed Protection Approach
(U.S. EPA, 1995b)

Although the general framework outlined by EPA is eminently sensible, the EPA provides limited specific technical direction. Technical specifics are available only by inference from case study descriptions (U.S. EPA, 1995a,b). Tools for analysis such as models are not provided, although the application of existing wasteload allocation procedures to watershed analysis is described (U.S. EPA, 1992b). The incorporation of wasteload allocation procedures into watershed protection returns to the water quality-based approach that failed prior to 1972. The complexity of this approach can be appreciated from Figure 13, which is excerpted from a recent EPA guidance document (U.S. EPA, 1994b).

Despite the lack of rigor and the general vagueness of EPA's description, watershed protection offers some intriguing and potentially far-sighted alternatives to prior regulations. An example is river restoration, the reconstruction of river environments to replace engineered channelized streams with the former natural geometry of a sinuous stream that meanders through a forested floodplain (NRC, 1992; Rosgen, 1993). Such reconstruction offers floodplain and bankfull storage for better flood control, stream geometry that provide aquatic habitat, a riparian buffer that provides NPS treatment, and natural shading that lowers stream temperature and improves water quality.

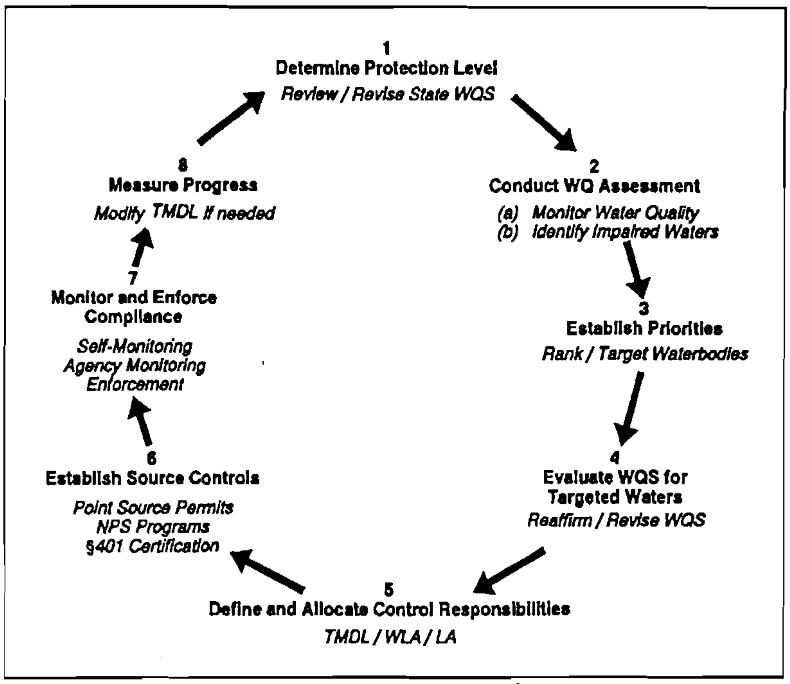

Figure 13

Water Quality-based Approach
(U.S. EPA, 1994b)

The water quality-based approach used in watershed protection and toxics control (U.S. EPA, 1991a,c) may seem a return to the regulatory nightmare that hampered water-quality improvement efforts prior to 1972. However, the situation has changed considerably, and the water quality-based approach today is hardly a recurring nightmare. Among the differences today are the availability of better modeling tools and technical guidance, and most importantly, an experienced group of personnel to apply them. More water-quality data enable better model calibration, especially when the new model is the second or third generation for the receiving water. Finally, and perhaps most importantly, the burden to complete allocations for all receiving waters in an unrealistically short time is no longer a factor. Today's studies are not intended to fill a regulatory void as was the case in the late 1960s, but rather to fine-tune and extract more information from previous efforts.

CONCLUDING OBSERVATIONS

The water-quality management system employed in the United States is a unique response to the institutions, finances, and water-quality conditions of that nation, and thus do not represent a specific model for the Central and Eastern European countries. Nonetheless, the U.S. experience offers useful insights for these countries as they develop new institutions, legislation, and policies for water-quality management.

First and foremost, the experience of the U.S. (and of other countries) is one of nearly constant change. Sweeping changes were made in 1972 and established the basic framework that remains today. However, within this overall framework, there have been nearly constant shifts in emphasis, modifications of the rules, and alterations in financing.

Second, the cost of water-quality improvement was vastly underestimated as was the time required to achieve water-quality goals. Legislative initiatives emphasized (and underestimated) investment in capital, however the long-term picture has been of constantly rising operations and maintenance costs that today dominate the water pollution abatement equation.

Third, retrospective evaluation of America's water-quality initiative has been clouded by inadequate water-quality data. Although the improvement in the nation's water quality is widely perceived and appreciated, it is not clearly demonstrated by water-quality data. The singularly missing component is a comprehensive data set that characterizes baseline conditions prior to the passage of water-quality legislation in 1972 and which would serve as the touchstone for later measurements.

Fourth, achieving the water-quality goals of 1972 has been a Zeno's paradox for the United States: despite every improvement in water quality, there yet remains a gap from the final goal. The fault is the wide diversity in the causes of water-quality impairment. The initial progress in conventional pollutants only revealed the importance of toxic substances; the control of point sources only showed the remaining importance of nonpoint sources. Today, the U.S. continues to experiment—this time with the watershed protection approach—with new ways to address the nonpoint source causes of water-quality impairment.

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